

AC370W-24V

(115Vac, 47-800Hz INPUT)

370W MULTIPLE OUTPUT,
AIRBORNE PFC POWER SUPPLY



Providing four isolated output voltages and up to 370W continuous output power, the **AC370W-24V** is optimized for wide frequency RTCA/DO-160F airborne applications. Incorporating synchronous rectifiers and precision control, overall supply efficiency exceeds 82% at full rated output load. With inclusion of external hold-up capacitors the **AC370W-24V** is capable of providing up to 370W output power during momentary input AC interrupts lasting 200mSec or more.

The main 24Vdc/ 270W output can be controlled digitally in order to adjust the output level from 23.35Vdc to 26.65Vdc; this output also contains remote sense and can be enabled/ disabled independently from the remaining three outputs.

Weighing less than 42 ounces, the **AC370W-24V** is housed within a machined enclosure suitable for flush mounting within an upper unit level chassis. Outline dimensions are 8.15" x 5.47" and overall supply height is 1.15". Interconnection is accomplished using five right angle Molex connectors. High power magnetics are located within thermally encapsulated cavities facilitating high power throughput and superior heat transfer.

The **AC370W-24V** is designed and manufactured to stand-up to the harsh operating environments encountered in today's aircraft installations. Incorporating multiple layers of built-in protection features; including overcurrent, over-voltage and overtemperature; safe and reliable operation is assured for each and every application.



FEATURES

	Four standard outputs: +7.5V, +24V nominal, $\pm 12V$
	Meets both RTCA/DO-160F, section 16, and Airbus ABD0100.1.8 issue D for power factor and input current harmonic distortion levels over the wide frequency operating range (360Hz – 800Hz)
	Complies with RTCA/DO-160F for conducted emissions, susceptibility and power input (sect 16), see note 3
	Efficiency: >82% at full rated load
	Wide input range: 96 – 134Vac, 47-800Hz
	Active inrush current limiting: 10Apk
	Size: 8.15" x 5.47" x 1.15"; Weight: less than 42 ounces
	Independent over-current and over-voltage protection on each output
	Input AC valid status line (TTL) and DC output valid status line (TTL)
	PFC output overvoltage protection with automatic restart (internal 360Vdc PFC output)
	Over-temperature protection and supply housing temperature monitoring signal (digital)
	MTBF: 369,000 Hours, RIAC 217Plus, Aic category, 50° C case temperature, 65%DC, 2190 Cycles/ year

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STANDARD OUTPUTS

PARAMETER	OUTPUT VOLTAGE			
	+7.5V	+24Vnom	+12V	-12V
Voltage Regulation	± 2.5%	± 1%	± 2.5%	± 2.5%
Output Current	9.4A	10A	2.1A	300mA
Maximum Load	70W	270W	25W	3.6W
Minimum Load	0A	0A	0A	0A
Pk-pk Ripple + Noise (20MHz)	150mVpp	480mVpp	240mVpp	240mVpp
Overcurrent Trip-point	11A	14A	6A	1A
Notes	1, 2	1, 2	1, 2	1, 2

- Notes:
1. Constant current limited
 2. Regulation for the 24V output is +/-1% of the programmed set point. Nominal set point for this output is 24Vdc and is preprogrammed in non-volatile memory. Programmable range is 23.35Vdc to 26.65Vdc.
 3. Requires external filter installed on power lines for full compliance; see application section for details.

APPLICABLE SPECIFICATIONS

	RTCA/DO-160G, section 4, altitude/ temperature (operating) to 15,000 feet, category A1 equipment
	RTCA/DO-160G, section 6, humidity (operating) category A
	RTCA/DO-160G, section 7, shock (operating) category S, curve C
	RTCA/DO-160G, section 8, vibration (operating) category S, curve C
	RTCA/DO-160G, section 15, magnetic effect, category B
	RTCA/DO-160G, section 16, power input requirements for 115V - AC input, category A(WF) equipment
	RTCA/DO-160G, section 17, voltage spike, category B equipment
	RTCA/DO-160G, section 18, conducted susceptibility, category Z equipment
	RTCA/DO-160G, section 19, induced signal susceptibility, category Z equipment
	RTCA/DO-160G, section 20, conducted and radiated susceptibility, category T equipment
	RTCA/DO-160G, section 21, conducted and radiated emissions, category M equipment, with external power line EMI filter
	Operating temperature: -25°C to +70°C, forced air and/ or external heatsinking may be required
	Storage temperature: -55°C to +100°C

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INTERCONNECTION

Connector	J101	J102	J103	J104	J105
Pin #	Samtec 20-pin p/n IPL1- 110-01-L-D-RA-K	Samtec 6-pin p/n IPBT- 103-H1-T-D-RA	Samtec 4-pin p/n IPBT- 102-H1-T-D-RA	Samtec 10-pin p/n IPL1- 105-01-L-D-RA-K	Samtec 16-pin p/n IPL1- 108-01-L-D-RA-K
1	REM_ADJ_CS	115Vac LINE	+360Vdc	+7.5V	+24V
2	REM_ADJ_SPI_SCLK	CHASSIS	PSRTN	DCRTN	+24V
3	REM_ADJ_SPI_SDI	115Vac NEUT	+360Vdc	+12V	+24V
4	+24V_EN	115Vac LINE	PSRTN	-12V	+24V
5	ACPF-L	CHASSIS	--	DCRTN	+24V_SNS+
6	+7.5V DC RTN	115Vac NEUT	--	nc	nc
7	TEMP_SNS_EMIT	--	--	nc	+7.5V
8	TEMP_SNS_BASE	--	--	+12V	+7.5V
9	OVF-L	--	--	-12V	+24VRTN
10	UVF-L	--	--	DCRTN	+24VRTN
11	+7.5V	--	--	--	+24VRTN
12	DCRTN	--	--	--	+24VRTN
13	+7.5V	--	--	--	+24V_SNS-
14	DCRTN	--	--	--	nc
15	+7.5V	--	--	--	DCRTN
16	DCRTN	--	--	--	DCRTN
17	nc	--	--	--	--
18	+12V	--	--	--	--
19	DCRTN	--	--	--	--
20	TEMP_SNS_ANALOG	--	--	--	--

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ELECTRICAL SPECIFICATIONS

Unless otherwise specified the following test conditions apply: Ta = 25°C, constant active load applied to each output, 900uF/ 450Vdc hold-up capacitance attached between J103-1 and J103-2. Vin = 115Vrms, 360Hz–800Hz, <1.25% sinusoid.

INPUT CHARACTERISTICS

PARAMETER	AC370W-24V	REMARKS	NOTES
INPUT VOLTAGE RANGE	96-134Vrms	Complies with normal / abnormal input voltages per DO-160F, sect 16	2
MUST START VOLTAGE	96Vrms minimum	Supply will start and remained enabled for input voltage in the range of 96Vrms < Vin < 134Vrms	2, 3
INPUT FREQUENCY RANGE	47 – 800Hz	Reduced distortion performance below 360Hz	2
EFFICIENCY (FULL LOAD)	82.5% typical at 115Vrms input 80% min at 115Vrms input	Full rated load (370W)	2
EFFICIENCY (50% LOAD)	80.5% typical at 115Vrms input 79% min at 115Vrms input	Half rated load (185W)	2
LEAKAGE CURRENT	< 3mArms	AC line / neutral to chassis at 115Vrms / 400Hz.	1
INRUSH CURRENT	<7Apk typical, 10Apk max	Cold or warm start	2
START-UP TIME	<750mSec	Outputs within proper regulation	2
INDIVIDUAL HARMONICS AC CLEAN	EVEN: <1% If / n (n < 10) EVEN: <0.1%If (n ≥ 10) ODD: <30% If / n ODD TRIPLENS:<15% If /n	If = fundamental current Vthd < 1.25% n = order of harmonic (1 - 99) 50% - 100% output load (50W-100W). Harmonics < 10mA disregarded	1
INDIVIDUAL HARMONICS DISTORTED INPUT	EVEN: <1% If / n + 1.25Vn (n < 10) EVEN: <0.1%If + 1.25Vn (n ≥ 10) ODD: <30% If / n + 1.25Vn ODD TRIPLENS:<15% If /n+1.25Vn	If = fundamental current Vthd > 10% (clipped method), n = order of harmonic (1 - 99) Vn = corr input voltage harmonic. 50% - 100% output load (50W-100W). Harmonics < 10mA disregarded	1
CONDUCTED EMISSIONS	RTCA/DO-160F	Section 21, category M	1, 4
QUIESCENT POWER	21W typical	Pout = 0W	2
STORAGE TEMPERATURE RANGE	-55°C TO +100°C	Non operational	1
OPERATING TEMPERATURE RANGE	-25°C TO +70°C	Requires external airflow or heatsink to assure case temperature does not exceed 100°C	1

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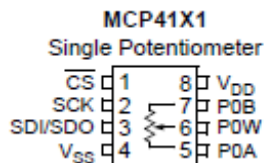


INPUT CHARACTERISTICS—CONTINUED

PARAMETER	AC370W-24V	REMARKS	NOTES
OVERTEMPERATURE SHUTDOWN	100°C +/- 4°C	Supply is inhibited at or above 100°C, auto re-start at ~ 80°C case temperature	1
+24V_ENABLE SIGNAL (+24V_EN)	3.3V logic. Apply 2.5Vmin on this signal to enable +24V output. Pull this low with respect to DCRTN (0.55V maximum) to disable +24V output	Maximum delay from assertion of +24V_EN signal until +24V output is in proper regulation is 100mSec. Maximum delay for +24V output to disable is 5mSec upon de-assertion of +24V_EN signal. Signal contains internal 10k pull down resistor.	2
REM_ADJ_CS SIGNAL	3.3V logic. 2.5Vmin logic high, 0.5V logic low	SPI serial interface; select adjust digipot. See +24V remote adjust section below for detailed timing and control information.	2
REM_ADJ_SPI_SCLK SIGNAL	3.3V logic. 2.5Vmin logic high, 0.5V logic low	SPI serial interface; data clock. See +24V remote adjust section below for detailed timing and control information.	2
REM_ADJ_SPI_SDI SIGNAL	3.3V logic. 2.5Vmin logic high, 0.5V logic low	SPI serial interface; data input line. See +24V remote adjust section below for detailed timing and control information.	2

+24V REMOTE ADJUST INFORMATION

The AC370W-24V power supply incorporates a Microchip Corporation p/n MCP4161-502E/SN 5k digitally controlled potentiometer in order to facilitate remote programming of the +24V output. The MCP4161-502E/SN “digipot” is an SPI controlled 8-bit 5k potentiometer operating from 3.3V logic. SPI timing and waveform requirements can be located in the Microchip data sheet. If not requiring field adjustment, the +24V output set point can be programmed to any value between 23.35V and 26.65V at the factory and this value will be stored permanently in non-volatile memory. If field adjustment is desired this can be accomplished using SPI control in accordance with the following guidelines.



+24V output voltage programmed value will adhere to the following formula and table:

$$V_{out} = 23.35V + \{(3.3V)(N) / 256\}, \text{ where } N \text{ is } 0\text{-}256 \text{ decimal}$$

Wiper Position (see IC excerpt)	Digital Code h=hex; d=decimal	Programmed +24V output (+/-1%)
P0W to P0A	100h (256d)	26.65Vdc
P0W to midscale	080h (128d)	25.00Vdc
P0W to P0B	000h (000d)	23.35Vdc

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OUTPUT CHARACTERISTICS

PARAMETER	AC370W-24V	REMARKS	NOTES
RATED OUTPUT POWER	370W	Continuous	2
OUTPUT VOLTAGE TOLERANCE	7.5V \pm 2.5%, 24V \pm 1%, \pm 12V \pm 2.5%	No load to full load, See "STANDARD OUTPUTS" table	2
24V REMOTE SENSE LINES (SNS+ and SNS-)	Maximum 700mV drop in output lines combined	Maximum allowable margin-up is 700mV for a \sim 27.35Vdc output if output is set to 26.65Vdc. If not used at point-of-load, sense lines should be looped back at module output pins. See application section for details. No damage will occur if sense lines are not connected	1
OUTPUT OVERCURRENT THRESHOLD	7.5V output: 11A 24V output: 14A 12V output: 6A -12V output: 1A	Constant current limited for each output, voltage will foldback. Auto-recovery into full load once fault clears. No damage will occur to supply during indefinite output short circuit conditions	2
TEMPERATURE STABILITY COEFFICIENT	0.05% / $^{\circ}$ C, each output	Output voltage variation with temperature (500uV / $^{\circ}$ C)	1
OUTPUT RIPPLE + NOISE (pk-pk)	7.5V output: <2% 24V output: <2% +/-12V output: <1%	20MHz Bandwidth	2
MINIMUM OUTPUT LOAD	0A, each output	No output load required for supply stability or proper output regulation	2
LINE REGULATION	<0.1%	Individual output deviation for \pm 20% step change in input voltage	1
LOAD REGULATION (TRANSIENT LOAD RECOVERY)	Outputs remain within regulation limits	50% step change in output load. Full load to half load or half load to full load. 10uSec rise/fall time	1
HOLD-UP TIME	220mSec @ Pout = 188W	900uF external hold-up capacitance attached to J103. Can be increased for higher power or longer hold-up durations. See app section for details	2
ISOLATION VOLTAGE INPUT TO CHASSIS	1500Vac, 60Hz	No arcing or damage for 60-second test duration (10mArms max leakage)	2
ISOLATION VOLTAGE INPUT TO OUTPUT	1500Vac, 60Hz	No arcing or damage for 60-second test duration (10mArms max leakage)	2
ISOLATION VOLTAGE OUTPUT TO CHASSIS	100Vdc	No arcing or damage for 60-second test duration (100Mohm min)	1
AC POWER FAIL-L (ACPF-L)	2.5Vmin logic high. ACPF-L signal transitions to 3.3V logic low (0.55Vmax at 24mAout) upon detection of loss of input AC	3.3V logic level, +/-24mA max sink/source current, 15mSec maximum delay time to activate on loss of input AC	2

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OUTPUT CHARACTERISTICS—CONTINUED

PARAMETER	AC370W-24V	REMARKS	NOTES
TEMPERATURE STATUS (TEMP-SNS-BASE) (TEMP-SNS-EMIT)	Provides analog sense voltage comprised of two signals: TEMP-SNS-BASE & TMP-SNS-EMIT to be input into external Texas Instruments TMP423 digital temperature IC	Monitors housing temperature, secondary side referenced, see application section for details	1
TEMPERATURE SENSE ANALOG (TEMP-SNS-ANALOG)	Provides analog sense voltage linearly proportional to Celsius temperature (10mV/°C) and has a 500mV offset (at 0°C)	Monitors internal supply PCB temperature, accurate to +/-1% over -40°C to 125°C temperature range, secondary side referenced	1
OVERVOLTAGE FAULT-L (OVF-L)	3.3V logic level. 2.5Vmin logic high. Transitions to 3.3V logic low (0.5Vmax at 16mAout) upon detection of any of the four supply outputs measuring >7.5% of upper regulation level	Secondary referenced, 10mSec delay time, TTL level, 8mA max source/ 16mA max sink current	1
UNDERVOLTAGE FAULT-L (UVF-L)	3.3V logic level. 2.5Vmin logic high. Transitions to 3.3V logic low (0.5Vmax at 16mAout) upon detection of any of the four supply outputs measuring <7.5% below lower regulation level. Fault is blanked for 24V output if 24V is disabled using 24V_Enable signal	Secondary referenced, 10mSec delay time, TTL level, 8mA max source/ 16mA max sink current	2
OUTPUT OVERVOLTAGE PROTECTION (non-latching)	+7.5V and +24V outputs limited to 120% of maximum output set point	Pulse-by-pulse protection, 4mSec fault to activation delay, auto-restart once fault condition clears	1
OUTPUT OVERVOLTAGE PROTECTION (latching)	+7.5V and +24V outputs limited to 130% of maximum output set point	Latching protection in the even "soft" OVP fails to operate. Supply will disable within 10mSec of OVP fault detection, requires AC power recycle to reset supply	1
PFC 360Vdc OUTPUT	360Vdc ± 3%	0W ≤ Pout < 370W	2
OUTPUT OVERVOLTAGE PROTECTION (PFC 360Vdc OUTPUT)	425V ± 5%	PFC converter is disabled upon detection of 360Vdc output measuring > 425Vdc. PFC converter will auto-recover if and when fault clears and output regains proper amplitude (auto reset)	1

Notes:

1. Ensured by design, not 100% tested in production.
2. 100% tested for specification compliance in production.
3. 24V_EN signal is not asserted during start-up and is asserted at least 1 second after input AC is applied.
4. Requires external filter (differential and common mode) installed on power lines for full compliance, see application section for details.

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APPLICATIONS INFORMATION

HOLD-UP TIME

The AC370W-24V power supply provides connector J103 for interconnection to external hold-up capacitors. In order to extend supply hold-up time, polarized 450V (minimum) electrolytic capacitors must be connected externally between the supply's +360V signals (J103-1,3) and PSRTN signals (J103-2,4). Required external capacitance can be determined using the following formula:

$$E = P * (t + t_{\text{restart}}) = (0.90) * \{ \frac{1}{2} C_{h/u} (\text{total}) (V_i^2 - V_f^2) \}$$

Where,

P = output power (Watts)

t = desired hold-up time (Seconds)

t_{restart} = warm start delay of approximately 25mSec upon reapplication of input AC

C_{h/u (total)} = total hold-up capacitance (Farads), includes internal 53uF (minimum) and external capacitance

C_{h/u (ext)} = external hold-up capacitance (Farads)

0.90 factor constitutes internal DC/DC converter efficiency

V_i = Minimum PFC voltage of 349dc (360Vdc - 3%)

V_f = Minimum internal DC/DC converter operating voltage of 180 Volts

$$E = P * (t + t_{\text{restart}}) = (0.90) * \{ \frac{1}{2} C_{h/u} (V_i^2 - V_f^2) \}$$

In order to hold up 370W external power for 200mSec requires:

$$C_{h/u} (\text{total}) = \{ (370W) (200\text{mSec} + 25\text{mSec}) \} \div \{ (1/2) (0.90) (349V^2 - 180V^2) \} = 2069\mu\text{F}$$

$$C_{h/u} (\text{ext}) = C_{h/u} (\text{total}) - 53\mu\text{F} = 2069\mu\text{F} - 53\mu\text{F} = 2016\mu\text{F} (\text{minimum})$$

Use of 105°C, 450Vdc, 20% tolerance snap-mount aluminum electrolytic capacitors is recommended. For the example above, a total nominal capacitance of 2520uF would be necessary to assure the required capacitance of 2016uF was achieved. Warm start delay occurs for AC power interrupts greater than 25mSec as a result of combination of time to reactivate PFC control circuitry, reinitiation of PFC soft-start cycle and reaching module power limit.

+24V REMOTE SENSE LINES

Remote sense capability is provided in order to "margin-up" the +24V output to overcome small system level voltage drops in traces and connectors. If using the remote sense lines, the maximum allowable system level voltage drop (or combined differential voltage between Vout and +SNS and DGND and -SNS) is 700mV. Exceeding this amplitude may force the supply's overvoltage protection circuit to activate. If not using the remote sense line feature at a remote point-of-load, each sense line should be terminated at the appropriate output pins of the supply: +SNS to +24V (J105-5 to J105-1) and -SNS to +24VRTN (J105-13 to J105-9). To assure supply stability the remote sense lines should be connected directly to the +24V and +24VRTN power forms prior to any additional inductive filter elements that may be included.

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OUTPUT RETURNS

DCRTN and +24VRTN are separate power planes within the power supply and are single point grounded near the J105 output connector. All logic input/ output signals are secondary side and are referenced to DCRTN. DCRTN/ +24VRTN are capacitively coupled to chassis ground with 5.1uF, 100V rated capacitors.

EMI CONSIDERATIONS

Although the AC370W-24V power supply contains internal common-mode and differential mode input filtering the use of an external inductive based line filter is required for full DO160 EMI compliance. Proper filter configuration is mandatory in order to assure emissions requirements as well as DO160 harmonics requirements. PPI offers two suitable off-the-shelf chassis mount EMI filters that provide sufficient differential and common mode attenuation for EMI compliance while minimizing internal X capacitances to assure minimized harmonic distortion content; particularly at lighter loads when operating at 800Hz input frequency. The two EMI filters are differing in size; each is chassis mount with solderable terminal lugs. Please contact PPI Engineering for further information and part numbers.

SAFETY CONSIDERATIONS

Assure that there is at least 4.2mm isolation distance between primary referenced wires and signals (line, neutral, +360V, PSRTN) and secondary referenced wires and signals (+24V, +7.5V, +/-12V, DCRTN, +24VRTN and I/O status and control signals). Assure that there is at least 3mm isolation distance between line and neutral bare conductors and signals. Assure that there is at least 4.2mm isolation distance between +360V and PSRTN bare conductors and signals.

THERMAL CONSIDERATIONS AND POWER DERATING

The AC370W-24V supply will provide full load (370W) output up to 80°C housing temperature. Beyond this temperature output power derating is required for the +24V output based on the supply's housing temperature. For housing temperature between 80°C and 90°C output load demand on the +24V output must be decreased by 10% (27W). For housing temperature between 90°C and 100°C output load demand on the +24V output must be decreased by 20% (54W).

The supply contains over-temperature protection that will disable the supply if the housing temperature ever exceeds 100°C (+/-4°C). Recovery is automatic once the housing temperature cools to ~80°C. External heatsinking and/ or airflow will be necessary to limit the housing temperature when operating above approximately 125W output power.

TEMPERATURE STATUS—DIGITAL

The AC370W-24V supply provides analog temperature sense signals (TMP_SNS_BASE and TMP_SNS_EMIT) that can be used to accurately measure the supply's housing temperature to within +/-1.5%. The sense signals are connected internally within the supply to the emitter-base junction of a silicon pnp transistor in a TO220 package flush mounted to the supply housing. The signals are intended to be input into an externally located Texas Instrument's TMP423 multi-channel temperature controller IC (or equivalent) which will measure temperature accurately over the range of -40°C to 127°C. Temperature is sensed via the emitter-base diode junction voltage drop established when passing a precision current source provided by the external TMP423 IC. The signals are properly filtered within the supply in accordance with the TMP423 design guidelines.